

The Carbon Budget of Ontario's Forests:

Phase I: The Carbon Stocks of Ontario's Managed Forest Lands for 1990 - The Monitoring Network

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Introduction

Carbon management is at the centre of efforts to mitigate the impacts of rapid climate change through emissions reduction and carbon storage under the Kyoto Protocol. Accordingly, quantifying carbon budgets is required by the Kyoto Protocol. For example, Article 5.1 states that Canada and other Annex 1 countries will establish "a national system for the estimation of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol." Given that forested ecosystems can store significant amounts of carbon and could be used as a carbon sink under Kyoto, carbon management projects must be rigorously monitored and their results verified and reported in a transparent manner (Kurz 1999).

To define the role of forests as carbon sinks and sources, we need to know how trees in forested ecosystems grow in relation to current and future conditions and management regimes. Monitoring and assessment programs provide the information needed to make science-based decisions about policies and activities aimed at understanding, conserving, and using forested ecosystems. As a monitoring tool, permanent sample plots (PSPs) provide the most reliable and efficient estimates of forest stand growth rates (Schreuder et al. 1993). PSPs also lend themselves to auditing and verifying reported activities under Kyoto (Kurz 1999). Use of PSP data is generally viewed as a more statistically robust method of evaluating forest change and of calibrating and validating forest dynamics models, including carbon budget models (Watson et al. 2000). In addition, PSP data can be used to assess model predictions.

Descriptive models (e.g., remotely sensed images) and predictive models (e.g., dynamic carbon budget process models) are valid and complementary tools for estimating and monitoring the flow of carbon. Ground-truthed data are important to validation and calibration projects (Kurz 1999, Schroeder et al. 1997). The number of plots required depends largely on the variability in the forest community and on the desired precision of the estimate. Initial estimates completed by the Ontario Ministry of Natural Resources (OMNR) in the 1990s indicated that 4,000 plots are required to reasonably cover the range of forest ecosystem conditions commonly found in Ontario (OMNR 1993).

Since 1992, OMNR has invested more than \$10 million in establishing and maintaining PSPs. The network includes more than 1,100 plots and is distributed across Ontario (Figure 1). Although gaps in geographic coverage and the types of forested ecosystems remain, this network provides a useful first series of measurements for modelling carbon budgets in many forested ecosystems throughout Ontario.

Carbon inventories can be incorporated into existing data collection programs, thus enhancing the overall utility of the data (Birdsey 1992). For example, in the course of collecting carbon data, information on commercial timber species production, biological diversity, and other measures of sustainable management can be collected. Traditional growth and yield programs have focused on quantifying timber volume, and these volume estimates can be used to calculate carbon content. For example, standing volume estimates are readily converted to estimates of standing biomass (Schroeder et al. 1997), and each unit of standing biomass is approximately 50% carbon by weight (Birdsey 1992). Similarly, tree growth measurements can be converted to quantify the carbon sequestered (Kurz 1999), a measure of net primary productivity.

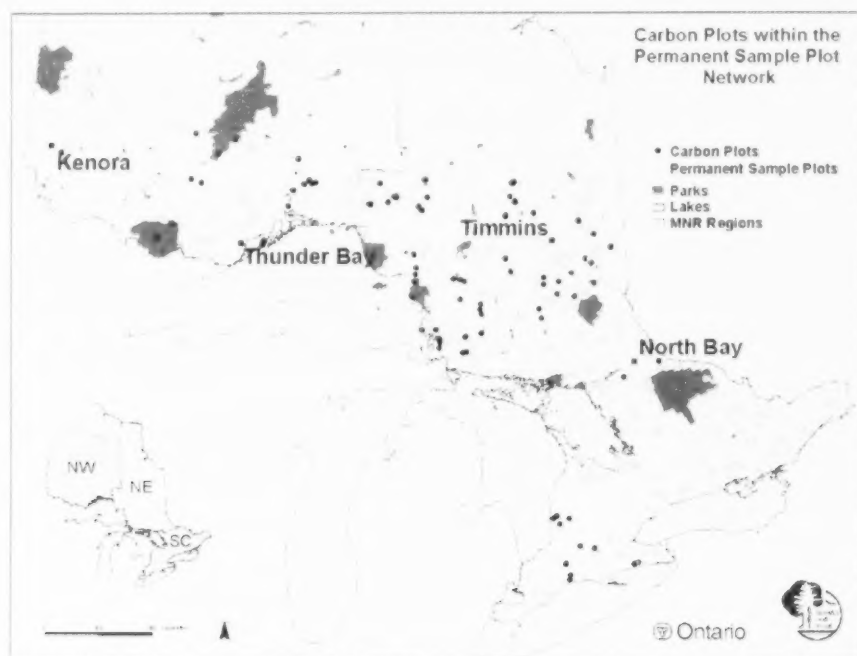


Figure 1. The permanent sample plot network administered by the Ontario Ministry of Natural Resources. The carbon plots are nested within this network.

Project Objectives

The objectives of this project were to:

- Establish a monitoring network of PSPs according to MNR's current methods (Hayden et al. 1995) in areas of the province that have few plots or that have under-represented forest types, such as white birch and white cedar; plots will be established in relatively undisturbed stands, 50 years of age or older
- Remeasure 80 historic growth and yield plots established by OMNR between 1970 and 1992 and forest industry between 1930 and 1980
- Store the data electronically and make it available to carbon budget modellers

Methods

A network of 36 PSPs was established in relatively undisturbed stands that were distributed across the Boreal and Great Lakes-St. Lawrence forest regions. Plots were selected to expand the geographic distribution of the existing plot network and to increase the number of plots in under-represented forested ecosystems. Eleven plots were established in provincial parks to support efforts to develop a better understanding of the role of parks and protected areas in Ontario's carbon budget. Provincial growth and yield protocols (Hayden et al. 1995) were followed to establish, maintain, and remeasure PSPs.

In addition to new plot establishment, 80 historic growth and yield plots were remeasured to quantify rates of carbon uptake and storage. Data were collected on the quantity of standing biomass in snags and living stems, the volume of coarse woody debris, and understorey vegetation and forest floor characteristics. Soil analyses were conducted on several of the new plots to support current and future carbon budget modelling projects (in some locations frozen soil conditions precluded complete capture of this data element). Data collected from these plots was provided to carbon budget modellers.

Products

The primary product of this project was a geographically extensive and comprehensive database for monitoring and assessing Ontario's forests. It provides forest overstorey and understorey data from relocatable sample points, similar to the BOREAS project data set (Halliwell and Apps 1997). These data permitted calibration of the *Carbon Budget Model for the Canadian Forest Sector* (CBM-CFS2) to estimate Ontario's carbon budget for 1990 (Peng et al. 2000). They were also used to calibrate and validate a new model for predicting forest growth and carbon and nitrogen dynamics (TRIPLEX) (Peng et al. 2002).

In the long term, repeated measurements on these plots will help quantify the role of forest cover in sequestering carbon and detect changes in vegetation community composition and structure resulting from climate change.

Another product is the PSP fact sheet (Figure 2), which provides users with a snapshot of local conditions and supplies a common reference to help explain data anomalies.

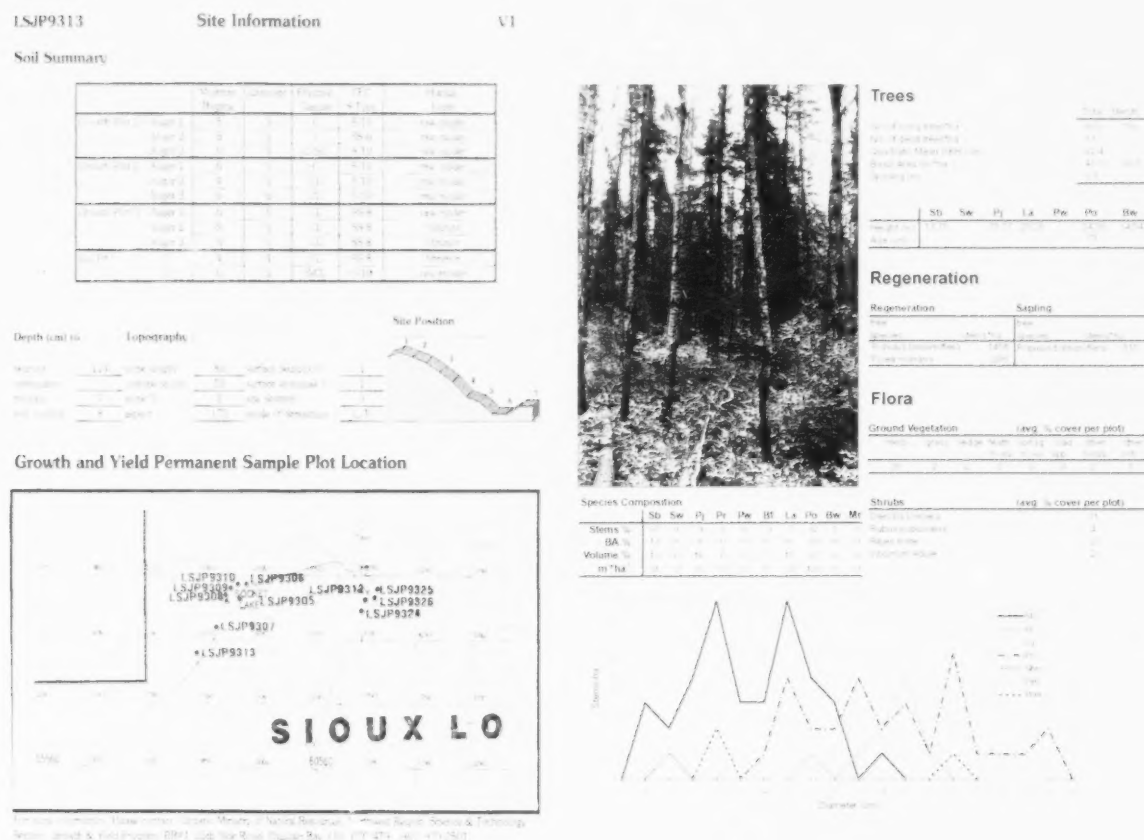


Figure 2. An example of a permanent sample plot fact sheet.

Next Steps

Future work will include:

- Maintaining and expanding the plot network
- Providing improved access to the data and publishing a summary report detailing plot locations and data summaries

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